Inside NIDCD Newsletter

National Institute on Deafness and Other Communication Disorders
National Institutes of Health

www.nidcd.nih.gov

Summer 2012

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Feature Story

The Cocktail Party Problem: How the Brain Decides What Not to Hear

By Robin Latham

The ability to pay attention to one voice among many in a crowded restaurant or party is something we take for granted—we focus on that one voice and screen out the rest—but how selective hearing happens in the brain is something that scientists have been curious about for decades. At least, since 1953 when a British researcher christened it the "cocktail party problem" and speculated that if we could understand the process of how the brain grabs onto the voices we want to pay attention to and pushes the rest aside, we could build a machine to replicate it.

Almost 60 years later, that machine is very close to becoming a possibility. A pair of NIDCD-supported researchers who study selective hearing have created a way to not only see how the brain filters and segregates competing voices, but to even predict the exact word someone is listening to. A report of their findings was published online on April 18, 2012, in the journal Nature at **http://www.nature.com/nature/journal/vaop/ncurrent/full/nature11020.html**.

Edward Chang, Ph.D., an assistant professor of neuroscience at the University of California, San Francisco (UCSF), is a neurosurgeon who operates on people with epilepsy. To help pinpoint the parts of the brain responsible for their seizures, his patients are implanted with a thin sheet of up to 256 electrodes beneath the skull on the outer surface of the brain's cortex. Over the course of a week, while the patient is in the hospital, the electrodes record the electrical activity of the neurons in the patient's temporal lobe.

UCSF is one of the few academic epilepsy centers that does these advanced intracranial recordings, which are so discriminating they can report the firings of single neurons. Dr. Chang and postdoctoral fellow Nima Mesgarani, Ph.D., realized they had a unique opportunity. While the electrodes were collecting evidence of seizures, they could also record the activity of neurons in the auditory cortex, the part of the brain that processes sounds, which resides in the temporal lobe. Three patients volunteered for the study, which was conducted in the hospital while they awaited surgery.

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"What we found was that the auditory cortex is in and of itself pretty sophisticated. It's as if it knows which sounds should be grouped together and only extracts those that are relevant to the single speaker."
—Edward Chang, Ph.D.

In the experiments, the subjects listened to multiple trials of two different speech samples played simultaneously. One of the sample speakers was male, the other female. Each speaker repeated a nonsensical phrase that combined a target word (ringo or tiger) spoken before a combination of a color (red, blue, green) and a number (two, five or seven) along with a connecting verb. A typical phrase was "ready **tiger** go to **red two** now." The subjects were told to pay specific attention to one of the two target words, which was also shown on a computer screen in front of them, and then report the color and number that the same speaker said afterwards.

The researchers analyzed the recordings using a newly developed and powerful decoding algorithm that scrutinizes the patterns of neural activity to reconstruct what the subjects heard. What the researchers found was that the neural responses in the auditory cortex only reflected the words of the targeted speaker. Apparently, the auditory cortex ignores what it doesn't want to hear, and focuses on what it does.

What this means, according to Dr. Chang, is that the auditory cortex is doing a lot more work than it had previously been given credit for. "A lot of people thought that the auditory cortex was just passing this information up to the cognitive part of the brain, the frontal cortex and the executive control areas, where it would be really processed," he says. "What we found was that the auditory cortex is in and of itself pretty sophisticated. It's as if it knows which sounds should be grouped together and only extracts those that are relevant to the single speaker." The information has already been analyzed in the auditory cortex before it leaves.

Drs. Chang and Mesgarani also discovered that the decoding algorithm could actually predict the speaker—as well as the specific words—that the subject was listening to based on the patterns of neural activity. In fact, the algorithm worked so well that it could predict not only the correct responses, but could also tell when the subject's attention strayed to the wrong speaker.

Besides these new insights into how the brain processes speech, Drs. Chang and Mesgarani have also developed a powerful tool in their new algorithm that could lead to advances in the field of automatic speech recognition—something we're all familiar with from frustrating phone calls to customer service lines. The current technology works well in quiet conditions, but with the addition of multiple speakers or background noise, it struggles. Dr. Chang suggests that what they've discovered about how the human ear processes competing sounds could be reverse-engineered into machine hearing.

Taking it even further, with a technique that allows scientists to peer into the auditory cortex to see, word by word, what it's listening to, doctors could begin to look at what is happening in the brains of people with dyslexia or attention deficit disorder. "Can you imagine how powerful it would be to peer into the mind of someone with dyslexia," says Dr. Chang, "to see how their auditory representations and word forms look in the brain?"

As the researchers look forward, they will be working on adapting the technology to a non-invasive method—one that wouldn't require surgical implantation—to make it a more practical method of recording neural activity in clinical settings. This would allow them, and other researchers, to look at speech processing in the brains of people with many different kinds of speech and language disorders.

This research is supported by National Institutes of Health (NIH) grant DP2OD008627, NIDCD grant R01DC012379, and a National Institute of Neurological Disorders and Stroke (NINDS) grant R00NS065120. NIDCD and NINDS are components of the NIH.

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Recent Research Highlights

NIH Scientists Explain How Cells Move in 3D

NIDCD intramural scientists Richard Chadwick, Ph.D., and Núria Gavara, Ph.D., along with researchers from the National Institute of Dental and Craniofacial Research (NIDCR), have published a paper in *The Journal of Cell Biology*. "Nonpolarized signaling reveals two distinct modes of 3D cell migration" identifies two ways in which cells can migrate in three dimensions, as well as the intracellular and extracellular factors that govern which mode of migration will occur.

The findings are important because cell migration plays a central role in a variety of biological processes, including fetal development, wound healing, inflammation, and the spread of cancer cells from one organ to another.

Dr. Chadwick is chief of the section on auditory mechanics in the laboratory of cellular biology at NIDCD. Dr. Gavara was a visiting fellow in the lab.

Read more on the NIDCD website at **http://www.nidcd.nih.gov/news/releases/12/Pages/050412.aspx**

The findings have been published in The Journal of Cell Biology at **http://jcb.rupress.org/content/197/3/439.abstract**

Inching to the Top

Among proteins, as among people, sometimes you just need a little help to get along. That's what a team of researchers in the NIDCD Laboratory of Cell Structure and Dynamics has recently discovered about a protein called myosin IIIB (MYO3B). MYO3B plays a supporting role in the growth and maintenance of stereocilia, the bristly protrusions from sensory hair cells in the inner ear that turn vibrations into the electrical signals that the brain recognizes as sound. Their finding is of interest not only to scientists who study hearing, but to cell biologists who want to understand more about how different kinds of proteins move molecules efficiently from one part of a cell to another.

The study, published in the February 21, 2012 issue of *Current Biology*, reveals a novel bit of cooperation between two proteins that allows one to get the other to where it needs to go. This new discovery is but one in a series of findings that have come out of the lab of Bechara Kachar, M.D., which is exploring how a tight-knit group of proteins work together to build, maintain, and regulate the precise height of stereocilia.

Read more on the NIDCD website at **http://www.nidcd.nih.gov/news/releases/12/Pages/040412.aspx**

The findings have been published in Current Biology at **http://www.ncbi.nlm.nih.gov/pubmed/22264607**

Variant of Usher Syndrome Gene Preserves Vision and Balance

Usher syndrome, an inherited, recessive disorder that causes deafness and blindness ("deaf-blindness") as well as balance problems, can result from a mutant copy of any one of several different genes. But surprisingly, some mutations of the same genes that cause Usher syndrome can cause hearing loss alone, without any accompanying blindness or balance problems. Someone with a recessive disorder inherits two mutant copies of a gene, one from each parent. The researchers wanted to find out what would be the effect on vision for an individual who inherits a deaf-blindness mutation of an Usher gene from one parent and a deafness-only mutation of that same Usher gene from the other parent.

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Thomas B. Friedman, Ph.D., head of the NIDCD Laboratory of Molecular Genetics, and Julie M. Schultz, Ph.D., along with a team of researchers, found that an alteration of an Usher gene that causes only deafness can preserve sight and balance when in combination with another alteration of the same gene that causes Usher syndrome, or deaf-blindness. This has important implications for genetic counselors and may open new prospects for future therapies for vision loss. Their study appears in the November 2011 issue of *Journal of Medical Genetics*.

Read more on the NIDCD website at **http://www.nidcd.nih.gov/news/releases/12/Pages/01062012.aspx**

The findings have been published in The Journal of Medical Genetics at **http://www.ncbi.nlm.nih.gov/pubmed/21940737**

NIDCD Researchers Identify Key Proteins of Inner Ear Transduction Channel

NIDCD-funded researchers have identified two proteins that may be the key components of the long-sought after mechanotransduction channel in the inner ear—the place where the mechanical stimulation of sound waves is transformed into electrical signals that the brain recognizes as sound. The findings are published in *The Journal of Clinical Investigation*.

The study used mice in which two genes, TMC1 and TMC2, had been deleted. The researchers revealed a specific functional deficit in the mechanotransduction channels of the mice's stereocilia (bristly projections that perch atop the sensory cells of the inner ear, called hair cells), while the rest of the hair cell's structure and function was normal.

These genes and the proteins they regulate are the strongest candidates yet in a decades-long search for the transduction channel that is at the center of the inner ear's ability to receive sound and transfer it to the brain. Andrew J. Griffith, M.D., Ph.D., chief of the molecular biology and genetics section and the otolaryngology branch at the National Institute on Deafness and Other Communication Disorders (NIDCD) at NIH, and Jeffrey R. Holt, Ph.D., an associate professor in the department of otolaryngology at Harvard Medical School's Children's Hospital in Boston, co-led the team that published the findings.

Read more on the NIDCD website at **http://www.nidcd.nih.gov/news/releases/11/Pages/112111.aspx**

The findings have been published in *The Journal of Clinical Investigation* at **http://www.ncbi.nlm.nih.gov/pubmed/22105175**

NIDCD Highlights

New 2012-2016 NIDCD Strategic Plan Now Available

The NIDCD recently released a new five-year Strategic Plan. The NIDCD Strategic Plan is designed to help the institute, including NIDCD staff and the National Deafness and Other Communication Disorders Advisory Council (NDCD), to prioritize its research funding by identifying areas of outstanding promise and areas where there are gaps in knowledge. To develop the 2012-2016 Plan, the NIDCD convened a series of working groups in our mission areas of hearing and balance; taste and smell; and voice, speech, and language. Input was also solicited from scientific experts, the NDCD Advisory Council, NIDCD staff, and the public. View or download the 2012-2016 NIDCD Strategic Plan or the Executive Summary at **http://www.nidcd.nih.gov/about/plans/strategic/Pages/Default.aspx**

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NIDCD Program Director Travels to Jordan

According to the First World Report on Disability released in 2011 by the World Health Organization, roughly one billion people in the world— close to 15 percent of us—live with a disability that makes access to health care, education, employment, transportation, information, and many other essential aspects of life extremely difficult. Communication disorders such as hearing loss and voice, speech, and language disorders likely represent a large portion of that number. Hearing loss alone affects roughly 278 million people worldwide.

These kinds of jaw-dropping statistics nudged Lana Shekim, Ph.D., program director of the voice and speech program at the NIDCD, to apply to the Embassy Science Fellowship Program to see if she could make a difference. The Embassy Science Fellowship is a program sponsored by the U.S. Department of State and open to scientists at federal agencies.

Dr. Shekim, who is multilingual and a fluent speaker of Arabic, spent two months this spring and early summer in Amman, Jordan, as a fellow of the U.S. Embassy. She was involved in assessing the services available for the care of Jordanians with communication disorders and also exploring opportunities for collaboration between the United States and Jordan to help people with communication disorders.

The NIDCD's Dr. Lana Shekim (right) and Dr. Ben Prickril (with the National Cancer Institute), who travelled with the Embassy Science Fellowship Program.
Photo: Mark Miller

Working with academicians, clinicians, health advocates, and other national and international non-governmental organizations, Dr. Shekim identified resources and programs that could help Jordan achieve the WHO's 2011 recommendations to better meet the needs of people with communication disabilities. These goals include adopting a national disability strategy and plan of action and strengthening and supporting research on disability.

Dr. Shekim also represents the NIDCD on the Fogarty International Center's International Representatives Committee and the Global Health Research Working Group. "It's important that we think about communication disorders as a global health issue," says Dr. Shekim.

Grants News

New Clinical Trial Grant Funding Announcements

Two clinical trial funding announcements issued in March 2012 use a new, cooperative agreement mechanism (U01 and U34) that allows NIDCD program officer Gordon Hughes, M.D., to serve as a project collaborator before and after an application is submitted. These new grant mechanisms combine extra scientific and programmatic involvement, including technical assistance, advice, coordination, and support above and beyond the levels required normally for program stewardship of grants. The grants, NIDCD Phase I/II/III Clinical Trials in Communication Disorders (U01) and NIDCD Planning Grant for Phase III Clinical Trials in Communication Disorders (U34), have rolling application dates: June 4, 2012; October 4, 2012; February 4, 2013; June 4, 2013; October 4, 2013; February 4, 2014; June 4, 2014; October 3, 2014; and February 4, 2015, by 5:00 p.m. local time of applicant organization. For more information, see PAR-12-123 at **http://grants.nih.gov/grants/guide/pa-files/PAR-12-123.html** and PAR-12-124 at **http://grants.nih.gov/grants/guide/pa-files/PAR-12-124.html**

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NIDCD Olfaction Grantees Elected to National Academy of Sciences

NIDCD grantees John R. Carlson, Ph.D., and Liqun Luo, Ph.D., were recently elected members of the National Academy of Sciences in recognition of their distinguished and continuing achievements in original research.

Dr. John Carlson

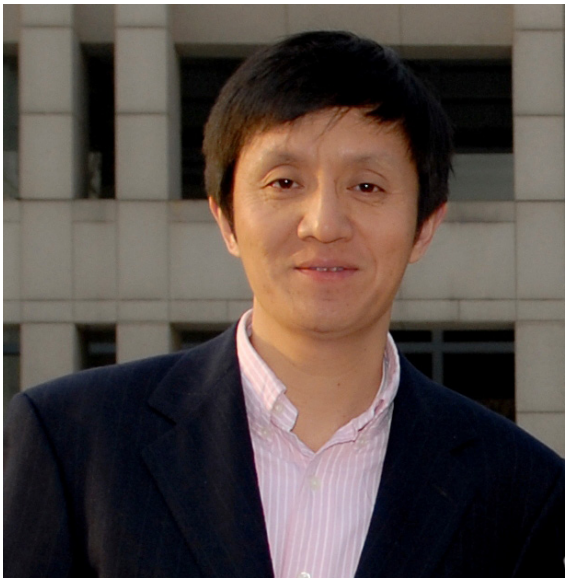
Dr. Carlson is the Eugene Higgins professor of molecular, cellular, and developmental biology at Yale University. His research has advanced our understanding of the function of taste and smell in insect model systems. "Each year, hundreds of millions of people suffer from diseases such as malaria that are transmitted by insects, and enormous damage is done to the world's food supply by insect pests," said Dr. Carlson.

His work has uncovered molecular and cellular mechanisms by which flies and mosquitoes identify food sources and human odors. His laboratory identified 60 odor receptor genes of the fruit fly, and a family of 60 genes that encode taste receptors. This knowledge may lead to new ways of controlling insect-borne diseases, disease vectors, and the safety of the world's food supply.

Dr. Luo is a Howard Hughes Medical Institute investigator in neurobiology and professor of biology and neurobiology at Stanford University. His research has helped us better understand the intrinsic connectivity of the developing brain. "Many neurological and psychiatric disorders originate from improper wiring of the brain," said Dr. Luo.

His studies focus on the exquisite wiring of a part of the nervous system that supports the sense of smell. Smell dysfunction often accompanies neurological disorders, and an understanding of the wiring underlying smell may help in our understanding of wiring problems in other neurological disorders. In addition, his team has identified key molecules that play a role in the neural circuitry associated with a variety of dementias and motor disorders. His work is also supported by the National Institute of Neurological Disorders and Stroke (NINDS).

The National Academy of Sciences is a private organization of scientists and engineers dedicated to furthering science and technology and using those advances for the general welfare. Election to the Academy is one of the highest honors that can be bestowed on a scientist or engineer. This year's class includes a total of 84 new members and 21 foreign associates from 15 countries.



Dr. Liqun Luo

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Meetings of Interest

Hearing Loss Association of America (HLAA), HLAA Convention 2010

June 21-24, Providence, R.I.

Web info: **http://www.hearingloss.org/content/convention**

HLAA presents its national educational program and trade show including special workshops for parents and educators, and a research symposium on How the Brain Makes Sense of the World of Sound. Charles Limb, M.D., associate professor of Otolaryngology-Head and Neck Surgery at Johns Hopkins University will moderate as well as present on the topic of music perception. Other presenters include Amanda Lauer, Ph.D., Brad May, Ph.D., and Frank Lin, M.D., Ph.D.

National Association of School Nurses (NASN), NASN 44th Annual Conference

June 23-26, San Francisco, Calif.

Web info: **http://www.nasn.org/ContinuingEducation/AnnualConference**

With the theme Advocacy, Access, Achievement: Making the Connection, this year's NASN's conference goals for school nurses are to summarize the current research and evidence for school nursing practice; describe ongoing efforts to promote health and prevent disease or disability in the school community; suggest achievable partnerships to support healthy policies and programs; and expand members' professional network. Visit the Noisy Planet booth (number 113) at this conference.

Alexander Graham Bell Association for the Deaf and Hard of Hearing (AG Bell), AG Bell 2012 Biennial Convention

June 28- July 2, Scottsdale, Ariz.

Web info: **http://nc.agbell.org/Page.aspx?pid=1338**

AG Bell's 2012 Biennial Convention offers something for everyone, including: 12 intensive short courses; 80 concurrent sessions for families, individuals with hearing loss, and professionals; 3 "super sessions" in parent advocacy, career transitions, and hearing loss; programming for children and teens; more than 60 exhibitors; and continuing education credits through the AG Bell Academy, the American Speech-Language-Hearing Association (ASHA), and the American Academy of Audiology (AAA).

National Association of the Deaf (NAD), 51st Biennial Conference

July 3-7, Louisville, Ky.

Web info: **http://nad.org/louisville**

This year NAD has partnered with DeaFeastival Kentucky, a gathering of visual and performing artists who celebrate the language, culture, diversity, and arts within the deaf and hard of hearing community.

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National Stuttering Association (NSA), 29th Annual Conference and Research Symposium

July 4-8, St. Petersburg, Fla.

Web info: **http://www.nsastutter.org/AnnualConference/index.html**

NSA's annual conference and research symposium offers adults and children who stutter, their families, and speech-language professionals interactive workshops, motivational speakers, and opportunities to network.

American Academy of Otolaryngology–Head and Neck Surgery Foundation (AAO-HNSF), Annual Meeting and OTO EXPO 2012

September 9-12 , Washington, D.C.

Web info: **http://www.entannualmeeting.org/12/**

AAO-HNSF's Annual Meeting and OTO EXPO 2012 is the world's largest gathering of otolaryngologists. More than 6,000 professionals from around the world, including physicians, researchers, and nurses, will review the latest research findings, earn continuing medical education credits, network with colleagues, and visit the most extensive state-of-the-art exposition of products and services of its kind.

Academy of Rehabilitative Audiology (ARA), ARA Institute 2012

September 9-11, Providence, R.I.

Web info: **http://www.audrehab.org./institute2012.htm**

ARA promotes excellence in hearing care by providing comprehensive rehabilitative and habilitative services.

Society for Neuroscience (SfN), Neuroscience 2012

October 13-17, New Orleans, La.

Web info: **http://www.sfn.org/am2012/**

Neuroscience 2012 is the premier venue for neuroscientists from around the world to debut cutting-edge research on the brain and nervous system. The annual meeting of the Society for Neuroscience offers lectures, symposia, and continuing medical education for scientists at all career stages.

American Public Health Association (APHA) Annual Meeting and Exposition

October 27-31, San Francisco, Calif.

Web info: **http://www.apha.org/meetings/AnnualMeeting/**

APHA's 140th Annual Meeting and Exposition offers the opportunity to learn from the experts in the public health field about cutting-edge research and best practices, products, and services. APHA's meeting program addresses current and emerging health science, policy, and practice issues in an effort to prevent disease and promote health.

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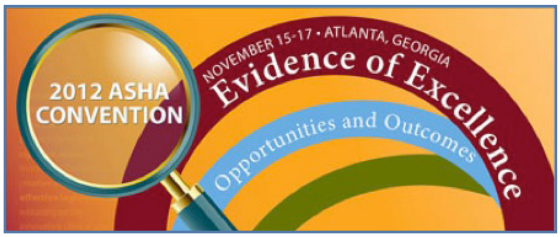
American Speech-Language-Hearing Association (ASHA), 2012 ASHA Convention
November 15–17, Atlanta, Georgia

Web info: **www.asha.org/events/convention**

The ASHA Convention provides a once-a-year opportunity to learn about the latest evidence-based research, polish your skills, improve your techniques and gain new tools and resources to advance your career and augment your workplace.



Beyond the NIDCD

Call for Grants Submissions

The American Hearing Research Foundation is accepting requests for grants related to hearing loss and balance disorders in the inner ear. Applications for the 2013 funding cycle are due on August 1, 2012. Find application guidelines and more information at **http://american-hearing.org/**

Vestibular Disorders Association Launches Updated Website and Celebrates Balance Awareness Week

The Vestibular Disorders Association (VEDA) recently relaunched its website featuring a new Members Forum and Latest News sections as well as the popular Provider Directory. The website contains information about vestibular disorders, including common symptoms, how vestibular problems are diagnosed and treated, and tips for coping with inner ear balance disorders.

VEDA also invites you to celebrate Balance Awareness Week, September 16-22. This year's theme is Defeat Dizziness. Find more information about VEDA and Balance Awareness Week at **https://vestibular.org/**

Three New DVDs from Stuttering Foundation of America

The Stuttering Foundation of America (SFA) has new DVDs available:

ADHD and Children Who Stutter. Dr. Joseph Donaher introduces the clinical characteristics of attention deficit with hyperactivity disorder (ADHD), scientific literature on stuttering and ADHD, and interventions that may improve therapeutic outcomes for children who stutter with coexisting attention and focusing concerns.

Neurophysiology of Stuttering. Dr. Martin Sommer gives an overview of essential neurophysiological findings that improve our understanding of the causes of stuttering.

Evidence-Based Practice and Practice-Based Evidence: Closing the Gap. Dr. Nan Bernstein Ratner explains why we need to use research and common-sense evidence to develop best practices in fluency treatment. Dr. Ratner provides a range of options for both clinical researchers and practicing clinicians who want to find, use, and integrate evidence of treatment effectiveness.

Find more information on SFA at **http://www.stutteringhelp.org/**

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New Resources

Updated fact sheets about hoarseness, vocal fold paralysis, and assistive devices are now available in print and online on the NIDCD website.

Hoarseness

Using your voice too much or too loudly can cause hoarseness, but sometimes hoarseness is also an indicator that something more serious is happening with the tissues and structures that make up the larynx or the muscles that control them. In this fact sheet, you'll learn about how your voice works, when to see your doctor if you're hoarse, how your doctor will make a diagnosis, disorders that can cause hoarseness, and research currently being done to better understand hoarseness. Read or print the fact sheet at **http://www.nidcd.nih.gov/health/voice/Pages/vocalabuse.aspx**

Vocal Fold Paralysis

Vocal fold paralysis is a voice disorder that occurs when one or both of the vocal folds don't open or close properly. In this fact sheet, you can learn more about the symptoms, causes, diagnosis, and treatment of vocal fold paralysis, as well as current research. Read or print the fact sheet at **http://www.nidcd.nih.gov/health/voice/Pages/vocalparal.aspx**

Assistive Devices

Assistive device or assistive technology refers to any device that helps someone with hearing loss or a voice, speech, or language disorder to communicate. In this fact sheet, you can learn more about what types of assistive devices are available, and research currently being conducted to improve assistive devices in the future. Read or print the fact sheet at **http://www.nidcd.nih.gov/health/hearing/Pages/Assistive-Devices.aspx**

Farm Materials Available from *It's A Noisy Planet*

If you live or work on a farm, you know how noisy it can get. Working with combines, tractors, or squealing pigs can put your hearing at risk. The NIDCD has developed materials for parents of children who live and work on farms to help them develop healthy hearing habits to protect their hearing for life. To download or order other farm-friendly materials, visit the *It's A Noisy Planet. Protect Their Hearing* website at **http://www.noisyplanet.nidcd.nih.gov/Pages/Default.aspx**

NIDCD is now on Twitter, and *It's a Noisy Planet* Opens a Page in Facebook

The NIDCD now has a Twitter handle, and the popular NIDCD education campaign on noise-induced hearing loss, *It's a Noisy Planet. Protect their Hearing*, now has a Facebook page. To join the conversation and receive the latest information from the NIDCD, follow us at **http://twitter.com/nidcd** and like the Noisy Planet Facebook page at **http://www.facebook.com/NoisyPlanet**

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